gradual preparation of elaborate maps of the German and Austrian Alps. At present it is engaged on a map of the Salzkammergut, on a scale of 1 : 100,000.

A LUNAR LANDSCAPE

MESSRS. GAMMON AND VAUGHAN, No. 28, Old Bond Street, have at present on view a picture in which the artist, Olafs Winkler, of Weimar, has endeavoured to represent a lunar landscape. Prof. C. Bruhns, of Leipzig, has assisted him in the parts of the treatment which are directly scientific.

The painter has not trusted all to his imagination. He has, to the best of his knowledge and ability, sought to stick rigidly to truth, and to paint a lunar landscape such as it would appear, so far as human observation has hitherto ascertained, to a human eye, were it at all possible for a man to be transplanted to the moon and observe through his earthly eyes, only for a moment, nature as she manifests herself on the surface of our satellite. From the merely artistic point of view the artist fears his task may be a thankless one, for since the moon has no atmosphere, there is neither aërial perspective nor diffusion of light, but it is precisely this point which should make our artist all the more interested in this unique production. The shadow of a body in the foreground will appear quite as black as the sky itself which closes the landscape like a flat steep wall, broken only by the quiet light of the stars. All lights appear equally strong at a distance and close at hand, and this also holds with the local colouring. In a word, there is wanting in the lunar landscape that which lends to our earth perspective, richness or tone, modulation, softness, and temper. It is our atmosphere we have to thank for most of the multitudinous coloured phenomena of the terrestrial landscape—phenomena which in our satellite are impossible. The sunlight falls upon the hills with blinding brightness, and cuts sharply across the deep black shadows. Its intensity rivals the electric light, and light effects of such a kind are far beyond the reach of our palettes. We must resort to some expedient to be able to introduce a medium between the extreme contrast of light and shade, a sort of half-tone, which, at the same time, must be the chief tone of the picture; this Herr Winkler has sought in the light of the earth, the true "earthshine."

The artist has chosen the time of sunset, and the region he has selected lies in the northern part of the moon. The spectator is supposed to be on the front slope of a mountain, the continuation of which in the background comes out as a closed ridge. At his feet one of the numerous *maria* spreads out, filled up with rills, circular hills, and large and small craters, stretching away to the distant mountain referred to. Before, us in the black sky, hangs the moon's moon, our earth. She sheds her pale, ash-coloured light over the rent, desolate, dead stone-fields. Only the highest points of the mountain-tops still glow in the light of the setting sun, no longer red, as here, but dazzlingly white, in consequence of the absence of atmospheric absorption. The earth is at the period of her course between Sagittarius and the Scorpion, Antares being nearly in the middle of the picture. Against his persuasion he has been compelled to make the milky way very weak, and the stars somewhat large in proportion to the earth.

Herr Winkler, in a paper read at the last meeting of the German Association, stated that his first impulse to undertake the picture was derived from Nasmyth and Carpenter's work on the moon.

Our only criticism of the picture refers to the colour of the earth and of the true earthshine. We doubt whether the earth is quite red enough, especially at the edges, and we doubt again whether, with the earth as ruddy as it is, the colour of the lunar landscape itself should not be rather more in harmony with it, as it is the true light source.

The picture is an admirable performance, and the science of it is so true that, as we hinted before, those of our artists who care to have a natural basis for their depiction of natural phenomena will learn much from this attempt to deal with a new order of phenomena.

EDISON'S TALKING-MACHINE[1]

MR. THOMAS A. EDISON has recently invented an instrument which is undoubtedly the acoustic marvel of the century. It is called the "Speaking Phonograph," or, adopting the Indian idiom, one may aptly call it "*The Sound-Writer who Talks.*" Much curiosity has been expressed as to the workings of this instrument, so I purpose giving an account of it.

All talking-machines may be reduced to two types. That of Prof. Faber, of Vienna, is the most perfect example of one type; that of Mr. Edison is the only example of the other.

Faber worked at the source of articulate sounds, and built up an artificial organ of speech, whose parts, as nearly as possible, perform the same functions as corresponding organs in our vocal apparatus. A vibrating ivory reed, of variable pitch, forms its vocal chords. There is an oval cavity, whose size and shape can be rapidly changed by depressing the keys on a key-board. A rubber tongue and lips make the consonants; a little windmill, turning in its throat, rolls the letter *r*, and a tube is attached to its nose when it speaks French. This is the anatomy of this really wonderful piece of mechanism.

Faber attacked the problem on its physiological side. Quite differently works Mr. Edison: he attacks the problem, not at the source of origin of the vibrations which make articulate speech, but, considering these vibrations as already made, it matters not how, he makes these vibrations impress themselves on a sheet of metallic foil, and then reproduces from these impressions the sonorous vibrations which made them.

Faber solved the problem by reproducing the mechanical *causes* of the vibrations making voice and speech; Edison solved it by obtaining the mechanical *effects* of these vibrations. Faber reproduced the movements of our vocal organs; Edison reproduced the motions which the drum-skin of the ear has when this organ is acted on by the vibrations *caused* by the movements of the vocal organs.

Figs. 1 and 2 will render intelligible the construction of Mr. Edison's machine. A cylinder, F, turns on an axle which passes through the two standards, A and B. On one end of this axle is the crank, D; on the other the fly-wheel, E. The portion of this axle to the right of the cylinder has a screw-thread cut on it, which, working in a nut, A, causes the cylinder to move laterally when the crank is turned. On the surface of the cylinder is scored the same thread as on its axle. At F (shown in one-half scale in Fig. 2) is a plate of iron, A, about $\frac{1}{100}$ of an inch thick. This plate can be moved toward and from the cylinder by pushing in or pulling out the lever H G, which turns in an horizontal plane around the pin I.

The under side of this thin iron plate, A (Fig. 2), presses against short pieces of rubber tubing, X and X, which lie between the plate and a spring attached to E. The end of this spring carries a rounded steel point, P, which enters slightly between the threads scored on the cylinder C. The distance of this point, P, from the cylinder is regulated by a set-screw, S, against which abuts the lever, H G. Over the iron plate, A, is a disc of vulcanite, B B,

[1] The figures in this article are taken from "Sound, a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Sound, for the Use of Students of every Age." By Alfred M. Mayer. Vol. ii. of "Experimental Science Series for Beginners." (Now in press and soon to be published by D. Appleton and Co.)

© 1878 Nature Publishing Group

with a hole in its centre. The under side of this disc nearly touches the plate A. Its upper surface is cut into a shallow, funnel-shaped cavity, leading to the opening in its centre.

To operate this machine, we first neatly coat the cylinder with a sheet of foil, made to adhere by coating the edges with shellac varnish, then we bring the point, P, to bear against this foil, so that, on turning the cylinder, it makes a depressed line, or furrow. The mouth is now

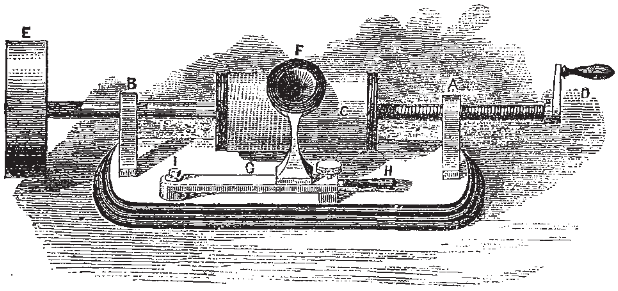

FIG. 1.—Edison's Talking-Phonograph.

placed close to the opening in the vulcanite disc, B B, and *the metal plate is talked to* while the cylinder is revolved with a uniform motion.

The plate, A, vibrates to the voice, and the point, P, indents the foil, impressing in it the varying numbers, amplitudes, and durations of these vibrations. If the vibrations given by the voice are those causing simple sounds, and are of a uniform, regular character, then similar, regular, undulating depressions are made in the

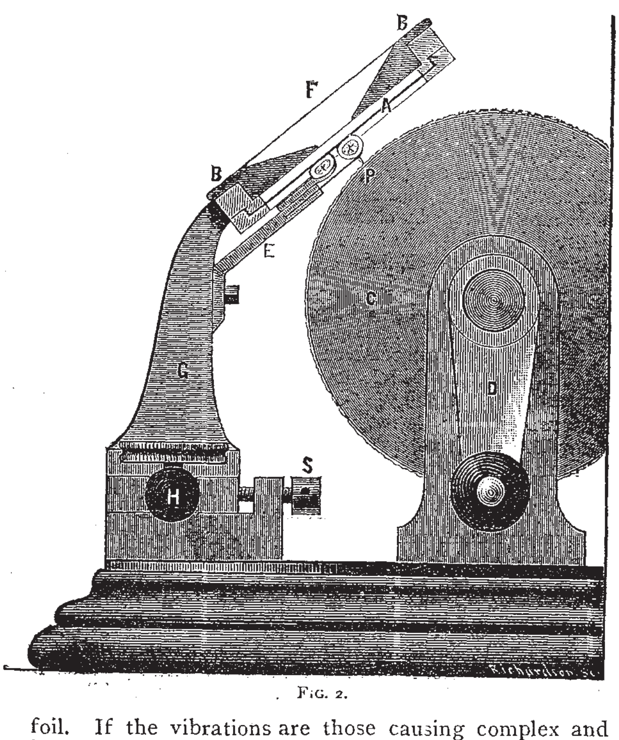

FIG. 2.

foil. If the vibrations are those causing complex and irregular sounds (like those of the voice in speaking), then, similarly, the depressions made in the foil are complex, having profiles like the curve, B, in Fig. 3. Thus the yielding and inelastic foil receives and *retains* the mechanical impressions of these vibrations with all their minute and subtile characteristics.

The permanent impressions of the vibrations of the voice are now made. It remains *to obtain from these impressions the aerial vibrations which made them.* Nothing is simpler. The plate A, with its point, P, is moved away from the cylinder by pulling toward you the lever, H G. Then the motion of the cylinder is reversed till you have brought opposite to the point P the beginning of the series of impressions which it has made on the foil. Now bring the point up to the cylinder; place against the vulcanite plate, B B, a large cone of paper or tin to re-enforce the sounds, and then steadily turn the crank, D. The elevations and depressions which have been made by the point, P, now pass under this point, and in so doing they cause it and the thin iron plate to make over again the precise vibrations which animated them when they made these impressions under the action of the voice. The consequence of this is, that the iron plate gives out the vibrations which previously fell upon it, and it *talks back to you what you said to it.*

By the following method we have just obtained several magnified traces on smoked glass of the contour, or profile, of the elevations and depressions made in the foil by the sonorous vibrations. On the under side of the shorter arm of a delicate lever is a point, made as nearly as possible like the point, P, under the thin iron plate, A. Cemented to the end of the longer arm of this lever is a pointed slip of thin copper-foil, which just touched the vertical surface of a smoked-glass plate. The point on the short arm of the lever rested in the furrow in which are the depressions and elevations made in the foil on the cylinder. Rotating the cylinder with a slow and uniform motion, while the plate of glass was slid along, the point of copper-foil scraped the lamp-black off the smoked-glass plate and traced on it the magnified profile of the depressions and elevations in the foil on the cylinder. I say expressly *elevations* as well as depressions in the foil, because, when the plate vibrates outward, the furrow in the foil often entirely disappears, and is always lessened in its depth by this outward motion of the point. One who has never made a special investigation of the character of the impressions on the phonograph, and forms his opinion from their appearance to his eye, might state that they are simply dots and dashes, like the marks on the filet of a Morse instrument

Another method of obtaining the profile of the impressions on the foil is to back it with an easily-fusible substance, and then, cutting through the middle of the furrows, we obtain a section, in which the edge of the foil presents to us the form of the elevations and depressions.

The instrument has been so short a time in my possession, that I have not had the leisure to make on it the careful and extended series of experiments which it deserves. I have, however, obtained several traces, and I have especially studied the characters of the trace of the sound of *bat.* As far as the few experiments warrant an expression of opinion, it seems that the profile of the impressions made on the phonograph and the contours of the flames of König, when vibrated by the same compound sound, bear a close resemblance.

In Fig. 3 we give on line A the appearance to the eye of the impressions on the foil, when the sound of *a* in *bat* is sung against the iron plate of the phonograph. B is the magnified profile of these impressions on the smoked glass obtained as described above. C gives the appearance of König's flame when the same sound is sung quite close to its membrane. I say expressly *quite close* to its membrane, for the form of the trace obtained from a point attached to a membrane vibrating under the influence of a compound sound depends on the *distance* of the source of the sound from the membrane, and the same compound sound will form an infinite number of different traces as we gradually increase the distance of its place of origin from the membrane; for, as you increase this distance, the waves of the components

© 1878 Nature Publishing Group

of the compound sound are made to strike on the membrane at different periods of their swings.

For example, if the compound sound is formed of six harmonics, the removal of the source of the sonorous vibrations, from the membrane to a distance equal to $\frac{1}{4}$ of a wave-length of the first harmonic, will remove the second, third, fourth, fifth, and sixth harmonics to distances from the membrane equal respectively to $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, and $1\frac{1}{2}$ wave-lengths. The consequence evidently is, that the resultant wave-form is entirely changed by this motion of the source of the sound, though the sonorous sensation of the compound sound remains unchanged.

The above facts are readily proved experimentally by sending a constant compound sound into the cone of König's apparatus, while we gradually lengthen the tube between the cone and the membrane next to the flame. This is best done by the intervention of one tube sliding in another, like a trombone. These experiments I have recently made with entire success, and they explain the discussions which have arisen between different observers as to the composition of vocal and other composite sound, as analysed by means of König's vibrating flames.

These facts also show how futile it is for any one to hope to be able to *read* the impressions and traces of phonographs, for these traces will vary, not alone with the quality of the voices, but also with the differently-related times of starting of the harmonics of these voices, and with the different relative intensities of these harmonics.

It is necessary to give to the cylinder a very regular motion of rotation while it receives and reproduces the vibrations made in singing; for even slight irregularities in the velocity of the cylinder destroy the accuracy of the musical intervals, and cause the phonograph to sing falsetto. Even the reproducing of speech is greatly improved by rotating the cylinder by mechanism which gives it uniformity of motion. If you make the machine talk by giving it a more rapid rotation than it had when you spoke to it, the pitch of its voice is raised; and by varying the velocity of the cylinder the machine may be made to speak the same sentence in a very bass voice, or in a voice of a pitch so high that its sounds are really elfish and entirely unnatural.

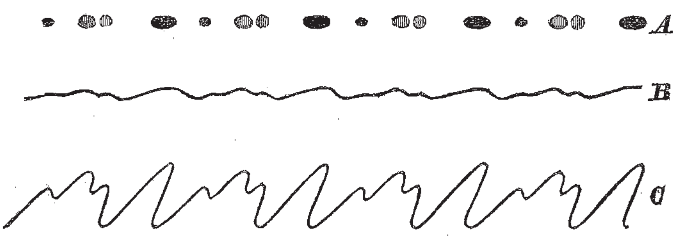

Fig. 3.

Recent experiments seem to show that the nearer the diaphragm A approaches to the construction of the drum-skin of the human ear by "damping" it, as the hammer-bone does the latter, the better does it record and repeat the sonorous vibrations; for the motion of a membrane thus damped is ruled alone by the aërial vibrations falling on it.

Mr. Edison has just sent me the following notes of the results of recent experiments:—

"That the size of the hole through which you speak has a great deal to do with the articulation. When words are spoken against the whole diaphragm, the hissing sounds, as in *shall, fleece, last,* are lost; whereas, by the use of a small hole provided with sharp edges, these words are reinforced and recorded. Also, teeth around the edge of a slot, instead of a round hole, give the hissing consonants clearer.

"That the best reading is obtained when the mouth-piece, B F B (Fig. 2), is covered with several thicknesses of cloth, so that the snapping noise on the foil is rendered less audible.

"I send you a sheet of copper-foil upon which I made records in Ansonia, Connecticut, that could be read 275 feet in the open air, and perhaps farther, if it had been tried."

Mr. Edison also states that impressions of sonorous vibrations have been made on a cylinder of soft Norway iron, and from these impressions have been reproduced the sonorous vibrations which made them.

Alfred M. Mayer

THE OLD RED SANDSTONE OF WESTERN EUROPE[1]

Part I.

In a historical introduction the author gives an outline of the progress of research into the history of the Old Red Sandstone of the British Area. This system is at present regarded as composed of three sub-divisions, Lower, Middle, and Upper, each characterised by a distinct suite of organic remains. From the absence of unequivocally marine fossils and from lithological characters, it has been inferred by Mr. Godwin Austen, Prof. Ramsay, Prof. Rupert Jones, as well as other observers, and is now very generally admitted that the Old Red Sandstone, as distinguished from the "Devonian" rocks, probably originated in inland sheets of water. The object of the present memoir was to endeavour to trace out in that geological system of deposits the changes of physical geography which took place over Western Europe during the interval between the close of the Upper Silurian and the beginning of the Carboniferous period.

After a sketch of the probable conditions of the region previous to the commencement of the Old Red Sandstone, the author proceeds to show how the shallowing Silurian sea was converted here and there into *salinas* or inland seas, by a series of subterranean movements which have left their indelible traces upon the upturned Silurian rocks. He divides his memoir into two parts, the first dealing with the Lower and the second with the Upper Old Red Sandstone. The present paper deals only with a portion of the first of these sections. It traces out the limits of the different basins in which the Old Red Sandstone of the British Islands were deposited, and for the sake of convenience as well as briefness of reference, proposes short geographical names for these basins, which are arranged as follows:—

[1] Abstract of paper by Prof. Geikie, F.R.S., read before the Royal Society of Edinburgh on April 1, 1878.

© 1878 Nature Publishing Group